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Growth performance and efficiency of protein utilization in giant tiger prawn, *Penaeus monodon* reared in tarpaulin pond with and without faecal chamber

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ABSTRACT

The accumulation of organic matter at the bottom of the pond greatly affects nutrient metabolism, feed efficiency, growth and productivity in giant tiger prawn cultivation. One of the causes is improper pool bottom construction The purpose of this study was to compare the growth performance and efficiency of protein utilization in giant tiger prawns consuming artificial feed supplemented with multi-enzymes and reared in tarpaulin ponds constructed between not and using the faecal chamber (FAMBER) or the space of metabolic waste and unconsumptioned feed (SOMECOF) at the bottom of the pond with a recirculating aquaculture system (RAS). A tarpaulin pond with a diameter of 3 m and a height of 100 cm filled with 80 cm of seawater. The tarpaulin pond is equipped with a transparent plastic roof, seawater and aeration installation, and a filter in the water pump tank. The average body weight of the experimental prawn used were 8-9 g. The feed given is pellet type artificial feed supplemented with multi-enzymes at a dose of 30 cc/kg of feed. The frequency of feeding were four times a day, namely at 07:00; 12:00; 17:00 and 22:00 with a dose of 5%. The parameters measured were growth performance including growth, condition factors and feed efficiency, while the efficiency of protein utilization included protein content, protein efficiency ratio, amino acid profile, index and score of essential amino acids of feed and experimental prawn. Data analysis was done descriptively. The results showed that all parameters of growth performance and efficiency of protein utilization in tiger prawns reared in tarpaulin ponds using FAMBER were better than those without FAMBER. Based on the results of the study, it was concluded that keeping giant tiger prawns in a tarpaulin pond using a FAMBER is better than not using a FAMBER.

INTRODUCTION

The development of giant tiger prawn cultivation, both extensification and intensification, are increasing, not only those reared in ponds in coastal areas but also those reared in concrete ponds and tarpaulins on land. Although giant tiger prawn cultivation in ponds is still dominant, cultivation in ponds located far from coastal areas has developed rapidly. Cultivation in ponds has several advantages, including prawn conditions that are easier to monitor, ponds have roofs so that fluctuations in temperature and salinity and other water quality parameters are more controlled, the distance from the house is closer so it saves cost and time, uses a smaller area, can also take advantage of coastal areas or sharp shorelines (coasts are not sloping) and can take advantage of household labor. Furthermore, the advantages of tarpaulin pond over concrete pond are that they can be transported or moved and handled easier, while concrete pond are permanent.

Basically, giant tiger prawns like to be at the bottom of the pond. This condition causes inedible feed, feces and other impurities that are at the bottom of the pond mixed with the giant tiger prawn that are kept. These impurities cause the level of turbidity to increase, dirt sticks to the gills so that tiger prawns have difficulty breathing, has the opportunity to cause accumulation of organic matter so that it increases the ammonia content which is very toxic to giant tiger prawns. According to Pangkey (2008), one of the most important things to pay attention to in an aquaculture system is that there must be a balance between aquaculture organisms and aquatic chemistry, and water quality parameters must be in optimal conditions for cultured organisms.

One solution to this problem is to reconstruct the bottom of the pond so that there is a special and separate room for the giant tiger prawns that are kept by creating a faecal chamber at the bottom of the pond called the space of metabolic waste and unconsumptioned feed (SOMECOF). The construction of a pond that has a faecal chamber will maintain guaranteed water quality and improve the process of nutrient metabolism, feed efficiency, protein utilization efficiency, growth and productivity. This will be even better if the pool is equipped with a filter with a recirculation aquaculture system (RAS).

Based on this, information about giant tiger prawn cultivation in tarpaulin ponds with and without a faecal chamber or FAMBER at the bottom with RAS is very urgent for the revival of giant tiger shrimp cultivation in Indonesia.

MATERIAL AND METHODS

Experimental Feed and Multi-Enzyme. The experimental animals used were giant tiger prawns obtained from the ponds of the Giant Tiger Shrimp Hatchery Installation (GHI), Siddo, Barru Regency, South Sulawesi (Figure 1) with a weight of 8-9 g. Stocking density 35 ind. m^{-2}. The giant tiger prawn were acclimated for a week to adjust the experimental feed and the environmental conditions of the tarpaulin pond.

Figure 1. The location of research in the Giant Tiger Shrimp Hatchery Installation (GHI), Siddo, Barru Regency, South Sulawesi.

The experimental feed used was commercial artificial feed number 3, which is a product of one of the national feed industry. The raw materials for the experimental feed consisted of fish meal, soybean meal, wheat flour, fish oil and premix with 31.0% protein content, 4.5% fat, 3.8% crude fiber, 16% ash, and 12% moisture.

The multi-enzyme used is the Biogreen Juara Enzyme from CV. Arjuna Brawijaya. The multi-enzyme composition was amylase 14.500 U. kg^{-1}, β-glucanase 14.000, phytase 26.000 U. kg^{-1}, cellulase 120.000 U. kg^{-1}, and xylanase 200.000 U. kg^{-1}. The multi-enzyme preparation was started by mixing 1000 g of multi-enzyme with 15 L of distilled water in a basin according to Saade *et a*l. (2020). Furthermore, the multi-enzyme mixing with the experimental feed was carried out by mixing 30 cc of multi-enzyme for one kilogram of feed. The experimental feed that had been added with multi-enzyme was air dried for several minutes while stirring.

Maintenance Container. The giant tiger prawn rearing containers used were two tarpaulin ponds, each of which uses and does not use a FAMBER at the bottom. The tarpaulin pond is equipped with a filter tank placed beside it and a submersible pump container to support the RAS. The two tarpaulin ponds are equipped with fiber tanks that function as sand filters located beside them, as well as seawater installations and aeration pipes. The aeration pipe is placed at the bottom of the pond which has fine holes with a distance of 30 cm between the holes. Seawater and its aeration come from waterways and aeration at the GHI.

The diameter of the tarpaulin pond was 300 cm and the height is 100 cm and is filled with water as high as 80 cm. In the middle of the pond there is a water outlet hole, the water that comes out of the bottom of the pond goes straight to the filter tank which is equipped with a stand pipe which also functions as a water level regulator in the tarpaulin pond, and above the tarpaulin pond there was a water intake pipe coming from the filter tank with the help of a water pump. For more details see Figures 2 and 3.

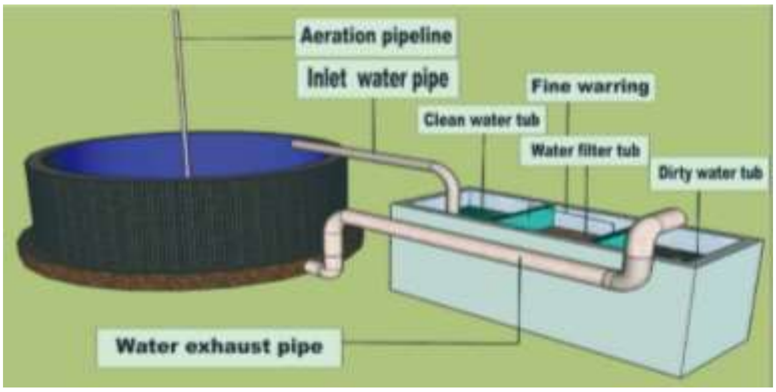

Figure 2. Tarpaulin pond and filter tub (viewed from the top side)

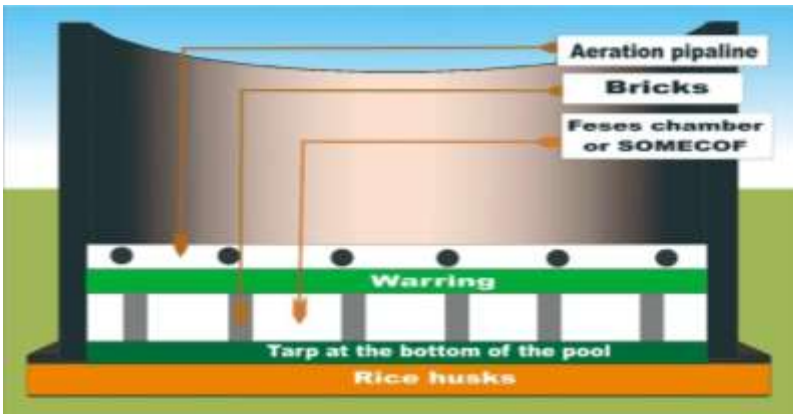

Figure 3. Faecal chamber (FAMBER) construction (viewed from the side)

Research procedure. The first step is to install tarpaulin ponds, pond roofs, aeration and water installations. After that, prawns were stocked with a density of 250 ind. pond^{-1}, and acclimated for a week and given commercial artificial feed at a dose of 5% per weight of biomass with a frequency of 4 times per day, namely at 07:00, 12:00, 17:00 and 22:00. On the next day, the experimental feed was given with the same dose and frequency of feeding as at the time of acclimation. The experimental feed was supplemented with multi-enzyme at a dose of 30 cc. kg^{-1} (Saade et al*.,* 2020).

Besides that, water quality measurements were also carried out including temperature, salinity, dissolved oxygen, pH and ammonia. Temperature measurements were carried out twice a day, in the morning and afternoon using a thermometer, salinity was measured daily using a salinometer, ammonia and dissolved oxygen were measured once every week, ammonia was measured by a spectrophotometer and dissolved oxygen (DO) was measured by a DO meter. Sampling of the experimental prawn was carried out every week to determine the body weight growth of the experimental prawn and to adjust the feed dose.

Parameters measured. Parameters measured were biological responses including survival rate, absolute growth, condition factors, feed conversion ratio, protein efficiency ratio, and protein qualities including amino acid profile, essential amino acid score (EAAS) and essential amino acid index (EAAI).

Survival rate. The survival rate of experimental prawn during the rearing period was carried out by counting the number of shrimps at the beginning and shrimp that lived until the end of the study. The survival rate was calculated by the formula (Effendie, 2003)

$$SR = \frac{N_t}{N0} \times 100\%$$

Notes:
SR = survival rate (%)
N_0 = the number of experimental prawn at the beginning of the study (fish)
N_t = the number of experimental prawn at the end of the study (fish)

Absolute growth. Absolute growth is calculated based on (Effendie, 2003).

$$AG = W_t - W_0$$

Notes:
AG = Absolute body growth (g)
W_t = Individual final body weight (g)
W_0 = Individual initial body weight (g)

Condition Factor. Condition factors are calculated based on (Dimenta & Machrizal, 2017).

$$CF = \frac{W}{L^3} \times 100$$

Notes:
CF = Condition factor
W = Body weight of experimental prawn (g)
L = total length of experimental prawn (cm)

Feed Conversion Ratio. Determination of the feed conversion ratio used the formula (Takeuchi, 1988).

$$FCR = \frac{F}{B_t - B_0}$$

Notes:
FCR = Feed conversion ratio.

B_t = Prawn biomass at the end of rearing (g)
B_0 = Prawn biomass at the start of rearing (g)
F = Amount of feed consumed (g)

Protein Efficiency Ratio. The protein efficiency ratio was determined using the formula Takeuchi (1988).

$$PER = \frac{W_t - W_0}{P_i} \times 100\%$$

Notes :
PER = Protein Efficiency Ratio (%)
W_t = Biomass of experimental prawns at the end of the study (g)
W_o = Biomass of experimental prawns at the beginning of the study (g)
P_i = Weight of feed consumed × protein content of feed (g)

Essential Amino Acid Score. The score for each essential amino acid (EAAS) is expressed as a percentage of the concentration contained in the standard protein. EAAS of the sample is expressed by the lowest number of essential amino acid scores**.** According to Muchtadi (2013) EAAS is calculated using the formula:

$$EAAS = \frac{Sampel\ Protein\ AAE\ Concentration}{Standard\ Protein\ AAE\ Concentration} \times 100\%$$

Essential Amino Acid Index. The essential amino acid index (EAAI) of the experimental prawn was carried out by comparing the AAE percentage of the experimental prawn with the AAE of eggs as a standard. According to Muchtadi (2013), the EAAI is calculated using the formula:

$$EAAI = \sqrt[n]{\frac{100a}{a_e} \times \frac{100b}{b_e} \times \frac{100c}{c_e} \times \ldots \times \frac{100j}{j_e}}$$

Notes:
a, b, c, and so on until j is the concentration of the sample essential amino acids
a_e, b_e, c_e, and so on until j_e is the concentration of standard essential amino acids
n is the number of essential amino acids

Sampling and Data Analysis. Sampling time including weight gain, essential amino acid index and essential amino acid score was carried out at the beginning, middle, and the end of rearing. The results of the study included survival, growth, feed efficiency, protein efficiency ratio, amino acid profile, essential amino acid index (EAAI) and essential amino acid score (EAAS) of experimental feed and shrimp in tarpaulin ponds with and without FAMBER were analyzed descriptively.

RESULTS AND DISCUSSION

Biological response (survival rate, absolute growth and condition factors), feed utilization efficiency (feed conversion ratio and protein efficiency ratio), protein quality (essential amino acid profile, non-essential amino acid profile, essential amino acid score/EAAS, essential amino acids index/EAAI), experimental feed, test shrimp in tarpaulin ponds with and without a space of metabolic waste, uncomsumptioned feed (SOMECOF), and fed commercial artificial feed added with multi-enzymes were different.

Biological response and efficiency of feed utilization. The survival rate (SR) of the experimental prawn obtained was 90.0% in tarpaulin ponds with FAMBER and 85.0% in ponds without FAMBER. In this study, the high SR of tiger prawns was caused by several factors. The first factor is the high nutritional content of the feed, as well as the addition of a multi-enzyme of 30 cc. kg^{-1} of feed. The nutritional content of the experimental feed was 30-32% protein, 4-5% fat, 3.8% crude fiber, and 16% ash. The nutritional content of the feed meets the nutritional needs of tiger prawns. This is in accordance with statements by several world nutritionists. New (1976) stated that prawn nutritional needs are 30-60% protein, and according to Deshimaru et al. (1979), tiger prawn fat needs are 6%, from research results Verdian et al. (2020) added that carbohydrate needs 21.55%, crude fiber 1.71% and ash 6.25%.

The second factor is the supply of sterile air and sufficient aeration from the GHI. The supply of clean water from microorganisms is a supporting factor and determines tiger prawns to survive and grow faster. Furthermore, a very strong aeration system provides oxygen for tiger prawns to live in conditions of high density. The stocking density of tiger prawns is 35 prawn. m^{-2}. During the study, dissolved oxygen in the maintenance medium was 6.28 ppm in the pond with FAMBER and 6.22 ppm in the pond without FAMBER. These dissolved oxygen values are ideal for optimal growth of giant tiger prawns. Murachman and Soemarno (2010) stated that optimal dissolved oxygen in giant tiger prawn rearing media is >4 ppm.

The third factor that makes tiger shrimp survival high are salinity, pH, temperature of the rearing media in optimal conditions. During the rearing of tiger prawns, salinity, pH and temperature average were monitored at 31 ppt, 8 and 31 °C, respectively. For details, see Table 1.

Table 1. Water Quality Parameters Monitored During Tiger Shrimp Culture in Tarpaulin Ponds With and Without FAMBER

Water quality parameters	Optimum value[1]	Tarpaulin ponds	
		With FAMBER	Without FAMBER
Temperatur (°C)	26-32	30	30
Salinity (ppt)	10-35	28	28
pH	7.8-8.7	8	8
Dissolved oxygen (ppm)	>4	6.28	6.22
Ammonia (ppm)	<0.1	0.0597	0.0753

Notes: [1]Murachman & Soemarno (2010).

The growth of absolute body weight (AG) and condition factor (CF) and production of giant tiger prawns in tarpaulin ponds with and without FAMBER were different (Table 2).

Table 2. Biological Responses and Efficiency of Feed Utilization in Giant Tiger Prawn Culture in Tarpaulin Ponds With and Without FAMBER

Parameters	Tarpaulin Ponds	
	With FAMBER	Without FAMBER
Numberof prawn (ind)	250	250
Stocking density (ind. m^{-2})	35	35
Average initial body weight (g)	8.1	8.1
Survival rate (%)	90.0	85.0
Average individual absolute growth (g. $prawn^{-1}$)	12.95	12.10
Condition factor	9.78	9.72
Giant tiger prawn production (kg)	23.17	10.91
Feed conversion ratio (FCR)	1.04	2.27
Protein efficiency ratio (PER)	4.65	2.25

Measurement of absolute growth aims to determine how much weight gain of giant tiger prawns during cultivation in tarpaulin ponds, while the measurement of condition factors aims to determine the ratio of growth in weight and body length of prawn, while production determines the total weight gain of giant tiger prawns during cultivation in tarpaulin ponds with and without FAMBER. The increase in weight or mass of giant tiger prawn meat is the main role of protein as a building material, while the increase in carapace length is the main role of experimental feed minerals. However, the role of protein and minerals and other nutrients will be meaningless if the maintenance conditions are not optimal, especially the construction of aquaculture containers or tarpaulin ponds. Growth and production are influenced by the quality and quantity of feed, cultivar (aquatic animals that are kept), water quality parameters and cultivation technology including the construction of aquaculture containers. Feeding in accordance with nutritional needs, mouth opening and eating habits will lead to increased fish growth (Hepher & Pruginin, 1981; Maryam, 2010).

The growth of absolute weight, condition factor and individual production of giant tiger prawns in tarpaulin ponds with FAMBER and without FAMBER were 12.95 and 12.10 g, 9.78 and 9.72, and 23.17 and 10.91 kg, respectively. Based on these three parameters, it can be seen that the tarpaulin pond with FAMBER was higher than the tarpaulin pond without FAMBER. The high growth in weight, condition factors and production of tiger prawns in ponds with FAMBER was suspected by the construction of pond bottoms using FAMBER. FAMBER acts on the side as a 20 cm high spacer on the inside at the base. The space at the bottom of the pond serves as a container for the deposition of melted feces so that there is a separation between feces and uneaten feed and the giant tiger prawns that are kept above it. Dirt that is in the 20 cm high chamber will be sucked in by the force of the water flow through the drain pipe (which is at the bottom of the middle of the tarpaulin pond) and out into the filter tank by the water pump inside. This causes a change in the water in the pond. According to Radhiyufa (2011), the speed of water change affects the decline in water quality due to the accumulation of feed residues, organic matter, phosphate compounds and toxic nitrogen. Meanwhile, the fine net above the bricks acts as a feed catcher so that it does not directly reach the bottom of the tarpaulin pond. This condition provides a good environment for giant tiger prawns to grow in size quickly.

Fulfillment of nutrition and feed in giant tiger prawn culture with a high density of 35 ind. m^{-2} with an average body weight of 8.1 g is the main factor for growth and production. In addition, feeding is done every day at 07.00, 12.00, 17.00 and 22.00 with a dose of 3-5% per body weight of biomass is a factor that determines growth, condition factor and production. Feeding in large quantities with a frequency of feeding is one way to avoid eating each other (cannibalism) between prawn, especially if there are prawn that molt. At the time of molting, shrimp emit an odor that triggers other shrimp to eat it. However, by offering large amounts of feed, it is hoped that the prawn will be full and not interested in eating other prawn.

In tarpaulin ponds without FAMBER, feeding in large quantities puts the experimental prawn with feces and the uneaten feed in the same space (bottom of the tarpaulin pond) from the previous feeding and of course has a direct impact on giant tiger prawns. Furthermore, if feces and other impurities accumulate at the bottom of the pond, there will be decomposition of organic matter by bacteria and will reduce dissolved oxygen (Soetomo, 1990), decreased appetite, weakness and sluggish movement. One of the characteristics of giant tiger prawns is that they like to be at the bottom of the pond, with these properties the giant tiger prawns will mix directly and be affected by the aroma caused by the smell of feces and uneaten feed as a result of overhauling organic matter by microorganisms.

The high condition factor (CF) obtained in tarpaulin ponds with FAMBER is an indicator that the growth of body cells is faster than tarpaulin ponds without FAMBER, especially in body weight growth caused by the addition of giant tiger prawn meat weight. The weight gain of tiger prawns is caused by the role of feed protein as a building material. This is due to the efficiency of protein utilization through a more efficient protein metabolism process in tarpaulin ponds with FAMBER. In tarpaulin ponds with FAMBER, feces and uneaten feed settle to the bottom of the pond through fine mesh openings attached to the top of the bricks. The settling of feces and uneaten feed provided a clean environment for the experimental prawns that were above the net (installed on the brick). Clean environmental conditions allow the process of protein metabolism to be more efficient and optimal. This affects the addition of body cells as well as the increase in higher growth in tarpaulin pools with FAMBER.

Meanwhile in tarpaulin ponds without FAMBER which resulted in the experimental prawn, feces and feed residues as well as the remnants of other metabolic products at the bottom of the tarpaulin pond. Tiger prawns are known to like to be at the bottom of the rearing container all the time along with other debris. This results in the tiger prawn’s metabolic process being not optimal, nutrient synthesis is disrupted and in the end the protein in the body is used as an energy source. Furthermore, a lot of wasted energy is used by the shrimp for adaptation to less clean-living media. When the energy supply is reduced, the protein in the body is remodeled into an energy source (NRC, 1983). One of the factors that influence the optimal nutrient metabolism process is the test shrimp environment under normal conditions.

Efficiency of feed nutrient utilization. The efficiency of the utilization of feed nutrients was measured based on the parameters of the feed conversion ratio (FCR) and the protein efficiency ratio (PER) by the aquatic animals cultivated. To determine the FCR, the amount of feed consumed was divided by the weight gain of giant tiger prawns, while PER was calculated by dividing the weight gain of the experimental prawn by the amount of protein in the feed consumed. The higher the PER value, the higher the efficiency of feed utilization, conversely the lower the FCR value, the higher the efficient level of feed utilization by the experimental prawn. Factors that affect FCR are feed quality, aquaculture technology, water quality, nutrient digestibility, and aquatic animal cultivated.

The FCR on the tarpaulin pond with FAMBER is 1.04 and without FAMBER is 2.27. The FCR of the tarpaulin pond with FAMBER is better than the tarpaulin pond without FAMBER. The high efficiency of feed utilization (FCR) in tarpaulin ponds with FAMBER was caused by the separation between experimental prawn and feces and uneaten feed at the bottom of the pond. Separation of feces and uneaten feed by the experimental prawn is the role of FAMBER who is at the bottom of the tarpaulin pond and provides a 20 cm high space as a place for the dirt to be sucked in by the force of the flow of water from the pump in the filter tank. It is suspected that this does not cause an unpleasant aroma around the experimental prawn at the bottom of the pond (above the fine net) causing nutrients and energy from the feed consumed by the experimental prawn to be more optimally used for higher growth so that feed efficiency or FCR is getting better. Furthermore, energy is needed in controlling chemical reactions to make new tissues, maintain osmotic pressure and salt balance, store or excrete body fluids, growth, reproduction and physical activity (Takeuchi, 1988).

On the other hand, in ponds without FAMBER, the feed and feces mixed with the experimental prawn. This causes the experimental prawn to be disturbed by the aroma caused by feces and uneaten feed from the previous feeding. The presence of this unfavorable smell forced the eksperimental prawn to expend extra energy to adjust. The impact is that not all of the nutrients and energy from the feed consumed is used for growth, and in the end growth is reduced and the FCR is high or feed efficiency is reduced.

In this study, the PER for tarpaulin ponds with and without FAMBER was 4.65 and 2.65, respectively. The efficiency level of feed utilization based on PER in tarpaulin ponds with FAMBER was higher than tarpaulin ponds without FAMBER, presumably because the protein digestion process by the experimental prawn was more optimal. Protein digestion is more optimal when supported by better water quality, such as dissolved oxygen. Although the dissolved oxygen in the two tarpaulin ponds was still in the optimal range, the reality showed that in the range of dissolved oxygen there was a higher value. Dissolved oxygen in tarpaulin ponds is influenced by the intensity of the performance of microorganisms in the breakdown of proteins contained in feces and uneaten feed, photosynthesis by plankton, prawn respiration, oxygen supply from aeration pipes, movement and circulation of water.

Furthermore, the feces and inedible feed in the tarpaulin pond with FAMBER separated more quickly from the experimental prawn so that the utilization of oxygen by microorganisms in the process of overhauling organic matter did not last long. The longer the organic matter is in the pond, the more it requires and reduces dissolved oxygen in the culture media. This is the role of FAMBER which provides a 20 cm high space at the bottom of the pond which allows dirt, organic matter to quickly settle to the bottom of the pond and was quickly sucked in by the water pump into the filter tank. Higher dissolved oxygen parameters will lead to more efficient protein digestion and growth processes which in turn increase the protein efficiency ratio.

Efforts to maintain giant tiger prawns in tarpaulin ponds are good and correct and get high productivity in the future, it is hoped that there will be efforts to increase the velocity of the water in the water discharge pipe by (i) increasing the elevation between the bottom of the tarpaulin pond and the bottom of the filter tank by more than 30 cm, (ii) increasing the power of the water pump, and (iii) increasing the slope of the bottom of the tarpaulin pond to the water outlet. The increase in the speed of water removal is intended so that uneaten feed and the remains of metabolism are faster or easier to exit from the bottom of the tarpaulin pond to the filter tank. This will avoid the process of overhauling organic matter by microorganisms and shorten the time together between the tested shrimp and feces.

Protein quality. The quality of protein is determined by the amino acids it contains. Amino acids derived from proteins of various types of ingredients in a mixed state can complement each other to produce protein and the composition of amino acids needed by the body for growth and maintenance (Almatsier, 2006). Protein quality includes amino acid (AA) profile including essential amino acids (AAE) and non-essential amino acids (AAEn), essential amino acid score (EAAS) and essential amino acid index (EAAI) feed and experimental prawn cultivated in tarpaulin ponds with and without FAMBER are listed in Tables 3, 4 and 5, respectively.

Table 3. Profile of Essential and Non-Essential Amino Acids in Feed and Meat of Experimental Prawn Kept in Tarpaulin Ponds With and Without FAMBER

No	Amino acid	Experimental feed	Meat of experimental prawn							
			Rarpaulin ponds with FAMBER				Tarpaulin ponds without FAMBER			
			Initial	Middle	Final	Mean	Initial	Middle	Final	Mean
A	**Essensial amino acid (%w/w)**	**12.66**	**22.83**	**25.69**	**34.47**	**27.66**	**22.83**	**31.89**	**26.21**	**26.98**
1	Arginine (%w/w)	2.91	3.74	3.92	4.99	4.22	3,74	4.42	4.04	4.07
2	Phenilalanine (%w/w)	1.22	2.19	2.44	2.9	2.51	2.19	2.64	2.43	2.42
3	Histidine (%w/w)	0.67	1.1	1.2	1.45	1.25	1.1	1.27	1.2	1.19
4	Ileusine (%w/w)	0.96	2.14	2.37	2.75	2.42	2.14	2.49	2.39	2.34
5	Leusine (%w/w)	1.67	4.02	4.41	5.05	4.49	4.02	4.67	4.48	4.39
6	Lysine (%w/w)	1.81	2.28	3.45	7.67	**4.47**	2.28	7.57	3.6	**4.48**
7	Methionine (%w/w)	0.32	1.24	1.38	1.69	1.44	1.24	1.56	1.37	1.39
8	Threonine (%w/w)	0.92	1.98	2.12	2.62	2.24	1.98	2.37	2.19	2.18
9	Serine (%w/w)	1.14	1.91	1.99	2.47	2.12	1.91	2.25	2.07	2.08
10	Valine (%w/w)	1.04	2.23	2.41	2.88	2.51	2.23	2.65	2.44	2.44
B	**Non-essensial amino acid (%w/w)**	**9.82**	**24.73**	**27.52**	**31.71**	**27.99**	**24.73**	**29.51**	**28.06**	**27.43**
11	Alanine (%w/w)	1.13	3.61	4.13	4.94	4.23	3.61	4.69	4.26	4.19
12	Aspartic acid (%w/w)	2.29	5.2	5.58	7.09	**5.96**	5.2	6.97	5.88	**6.02**
13	Glysine (%w/w)	1.2	4.21	4.86	5.65	4.91	4.21	4.92	4.78	4.64
14	Glutamate (%w/w)	4.53	10.14	11.14	11.93	11.07	10.14	11.04	11.38	10.85

No	Amino acid	Experimental feed	Meat of experimental prawn							
			Rarpaulin ponds with FAMBER				Tarpaulin ponds without FAMBER			
			Initial	Middle	Final	Mean	Initial	Middle	Final	Mean
15	Tyrosine	0.67	1.57	1.81	2.1	1.83	1.57	1.89	1.76	1.74
	Amino acid total (%w/w)	**22.48**	**47.57**	**53.21**	**66.18**	**55.65**	**47.57**	**61.41**	**54.27**	**54.42**

Notes: The results of the analysis of the Integrated Laboratory of the University of IPB Bogor.

Table 4. Essential Amino Acid Score (EAAS) in Experimental Feed and Giant Tiger Shrimp

Materials	Score of essensial amino acid (EAAS) (%)	
	Tarpaulin ponds with FAMBER	Tarpaulin ponds without FAMBER
Experimental feed	4.92	
Experimental prawn		
• Initial	19.08	19.08
• Middle	21.23	24.00
• Final	26.00	21.08
Mean	22.10	21.38

Table 5. Essential Amino Acid Index (EAAI) in Experimental Feed and Giant Tiger Shrimp

Materials	Essensial amino acid index (EAAI)	
	Tarpaulin ponds with FAMBER	Tarpaulin ponds without FAMBER
Experimental feed	16.99	
Experimental prawn		
• Initial	33.56	35.91
• Middle	37.94	43.60
• Final	48.88	38.50
Mean	40.12	39.33

Average the total AAE and AAEn of the experimental prawn, EAAS and EAAI of feed and prawn in tarpaulin ponds with FAMBER were higher than those without FAMBER. This is due to the empty space at the bottom of the tarpaulin pond with FAMBER. The empty space acts as a container for the waste or waste products of prawn metabolism (feces and urine) and feed that is not consumed. The separation between these impurities and the experimental prawn provides a clean environment around the prawn. Clean water supports the optimal process of protein and amino acid metabolism by the experimental prawn causing the amino acid content and growth of the experimental prawn to increase.

On the other hand, in tarpaulin ponds without FAMBER, which does not have empty space at the bottom, the experimental prawns and the waste products of metabolism and feed that are not consumed are mixed up. This condition causes the experimental prawn media to be unsterile or unclean, besides that there is an opportunity for prawns to consume previously inedible feed and feces. This condition causes the protein and AA metabolism processes to not take place optimally, so the average total AAE and AAEn of prawn, EAAS and EAAI of feed decreases and growth is lower in tarpaulin ponds without FAMBER. Furthermore, the amino acids contained in the body are utilized to meet other needs. Pramudiyas (2014) emphasized that if the amino acid metabolism process is not optimal, many amino acids will be deaminated and utilized for optimal needs.

Furthermore, the content of all types of AA (AAE and AAEn), EAAS and EAAI of the experimental prawn had a linear relationship with the time of rearing, i.e. the longer the rearing, the higher the content of AAE and AAEn, EAAS and EAAI. The increase in these values is supported by the presence of FAMBER which supports water quality conditions that are guaranteed from the beginning to the end of the cultivation. FAMBER plays a significant role in the separation between feces and other impurities with prawns. Giant tiger prawns need water that remains quality during cultivation. Water quality conditions that still meet the feasibility standards and do not fluctuate will encourage increased appetite and feed consumption, protein and AA metabolism processes and other nutrients to increase growth and production of shrimp culture in tarpaulin ponds. According to Effendie (2003), good water quality conditions will cause the physiological functions of the fish's (prawn) body to run smoothly. In conditions of poor water quality, energy is widely used for the physiological adaptation process of the fish body to the environment. This results in a smaller proportion of energy stored in the body. In addition, disturbed physiological conditions cause a decrease in feed consumption by fish to minimize the energy used, so that the fulfillment of the energy needed comes from nutrient reserves stored in the fish's body.

Meanwhile in tarpaulin ponds without FAMBER, the contents of AAE and AAEn, EAAS and EAAI only increased until the middle of cultivation and after that the values of these parameters decreased. This means that the efficiency of feed utilization and protein metabolism processes in tarpaulin ponds without FAMBER can only last until the middle of rearing, after which mixing between feces and other impurities at the bottom of the pond is inevitable. Small particles of feces and other impurities have the opportunity to stick to the gills of the prawn causing difficulty breathing and the body becomes weak. Finally, the tiger prawns live in a state of unclean water quality. This results in the efficiency of feed utilization and metabolic processes, especially protein and AA metabolism, which are not optimal. According to Mulyanto (1992), water conditions must be adjusted to optimal conditions for the growth of the biota being maintained.

The average AAE and AAEn of the experimental feed were lower than that of the experimental prawns at the beginning, middle and end of rearing tiger prawns in tarpaulin ponds with FAMBER or without FAMBER. This means that the amino acid content of the experimental feed is not sufficient to meet the amino acid requirement of the experimental prawn. However, the growth of tiger prawns was still significant in tarpaulin ponds with and without FAMBER. This is thought to be caused by tiger prawns consuming the experimental feed and consuming plankton (phyto and zooplankton) which grow rapidly in the rearing medium, although the population and density of plankton were not analyzed.

EAAS of experimental feed obtained a value of 4.92 on methionine. Meanwhile, the average EAAS of the experimental prawn in tarpaulin ponds with and without FAMBER was 22.10 and 21.38%, respectively (on methionine). This means that only about 4.92% of the total essential amino acids contained in the feed, as well as 22.10% (tarpaulin pond with FAMBER) and 21.38% (tarpaulin pond without FAMBER) that can be used by the body for protein synthesis. Therefore, methionine in the experimental feed and prawn is the limiting amino acid, which is the amino acid in the least amount, so it is called the limiting amino acid (Harris and Karmas 1989). The amino acid content in each species is the same, each species has different physiological processes. Differences in amino acid content can also be caused by age, season, and stage in the life cycle of organisms (Okuzumi & Fujii, 2000; Litaay, 2005).

The low EAAS of the experimental feed will slow down the use of protein and the formation of body tissues. Suprijatna et al. (2005) stated that even though the feed protein is in accordance with the needs, the deficiency of essential amino acids has an impact on the efficiency of the use of protein for the formation of body tissues. Therefore, in the preparation of feed, the protein and essential amino acid content must be sufficient (Sultoni et al., 2006), while the EAAI which uses the essential amino acid requirement as a standard also shows a value of 16.99%. This indicated that the average essential amino acid content in the experimental feed was 16.99%, resulting in a deficiency of each essential amino acid in the protein feed of 83.1%. The higher the EAAS the more perfect the quality and quantity of amino acids and protein in the feed.

The EAAI measurement of the experimental prawn meat used the essential amino acid content of eggs as a standard. The mean EAAI for tarpaulin ponds with and without FAMBER were 40.12% and 39.33%, respectively. These values indicate that the average essential amino acid deficiency in the experimental prawn meat is 59.88% in tarpaulin ponds with FAMBER, and

60.67% in tarpaulin ponds without FAMBER. The higher the EAAI value in the experimental shrimp, the higher the quality or the higher the contribution of essential amino acids of the experimental feed to the increase in essential amino acids of tiger prawns. Muhtadi (2013) added that increasing EAAI will increase nutrient absorption.

CONCLUSION

Based on the results of this study, it was concluded that the growth, efficiency of feed nutrients utilization and the quality of protein or amino acids in giant tiger prawns reared in tarpaulin ponds equipped with a faecal chamber (FAMBER) were better than those without FAMBER. Based on the results of this study, it is recommended to use tarpaulin ponds with FAMBER to increase productivity and export of Indonesian prawn.

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